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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/490,705	01/24/2000	Kazuyoshi Ueno	NECV-16.966	7525

26304 7590 09/16/2002

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EXAMINER

MAGEE, THOMAS J

ART UNIT	PAPER NUMBER
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2811

DATE MAILED: 09/16/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/490,705

Applicant(s)

UENO, KAZUYOSHI

Examiner

Thomas J. Magee

Art Unit

2811

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on 30 May 2002.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 2-11 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 2-11 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other:

DETAILED ACTION

Claim Rejections – 35 U.S.C. 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claim 2 is rejected under 35 U.S.C. 112, second paragraph, as lacking proper antecedent basis. The phrase, "said interconnect layer" has no prior reference.

Claim Rejections – 35 U.S.C. 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claim 2 is rejected under 35 U.S.C. 102(b) as being clearly anticipated by Donnelly et al. (US 6,143,658).

Donnelly et al. disclose (Col. 8, lines 4 – 26) a method for fabricating a device with two levels of wires (metallization) (copper) where an insulating film structure composed of two layers (220,270) (See Figure 2) is formed on top of the first copper deposited in the first via. The Si₃N₄ serves as the etch stop layer with the "insulating film" (SiO₂) formed on top. A second via is formed, terminating at the first metal. Cleaning is done by expos-

ing the substrate to an oxygen or hydrogen plasma, along with a separate "wet" clean by immersing the substrate in an HF solution (Col. 5, lines 62 – 67) Deposition (sputtering) of a barrier metal is done prior to forming copper plugs in the second via.

Claim Rejections – 35 U.S.C. 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office Action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 3 – 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Donnelly et al. in view of Tsuchiya et al. (Digest of Technical Papers, Symposium on VLSI Technology, (1997), pp. 59 – 60), and Hung et al. (US 2001/0008226 A1).

7. Regarding Claims 3 – 5, Donnelly et al. disclose, as mentioned above, the formation of two levels of wires, where a first copper plug is formed with an overlying "etch stop layer"(nitride) and an oxide on top. A second via is formed connecting with the first metal plug. Cleaning is done with a wet immersion dip (Col. 5, lines 62 – 67; Col. 8, lines 20 – 21). After cleaning and prior to forming the second copper plug, a TiN barrier layer is sputter deposited on the walls of the via (690) (See Figure 6C). Further, Tsuchiya et al. disclose (page 59, left column, lines 37 – 41; page 60, Figures 3 and 4) in Cu via formation that the oxygen plasma cleaning precedes the wet cleaning process. Donnelly

et al. do not explicitly disclose the process of "annealing" or the difference between plasma "treatment" and "annealing". However, Hung et al. disclose (page 6, left column, lines 20 - 29) a process for removing or cleaning residues from dielectric layers containing vias (18) (See Figure 9) in copper dual damascene interconnect structures in the presence of an oxygen plasma with zero or low bias power applied, as a plasma "treatment" step. Substrate heating is done through lamps at the top and bottom of the system (48,54) (See Figure 2) and regulated through controllers (64). Hence, it would have been obvious to one of ordinary skill in the art at the time of the invention to use the applied bias/controller approach of Hung et al. and the plasma/wet etch technique of Tsuchiya et al. to obtain separate steps of annealing and "treatment" to clean the via holes and to thereby combine Tsuchiya et al., and Hung et al., with Donnelly et al.

8. Claims 6 – 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Donnelly et al. in view of Tsuchiya et al. and Hung et al., as applied to Claims 3 – 5 above, and further in view of Activac Technology Inc. Auto 306 Data Sheet.

Donnelly et al. disclose that oxygen partial pressures are approximately 1 Torr and that exposure times are approximately one minute during exposure to an oxygen plasma (sputtering). Donnelly et al. do not disclose that the low pressure oxygen "annealing" is done in a sputter deposition system. It is extremely well known, that commercial sputtering systems are equipped with injection capabilities for a variety of gases, and substrate heaters for "annealing" (See for example, Activac Technology Auto 306 Sputtering

Art Unit: 2811

System Data Sheets, page 3, lines 5 – 7; 22). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use a commercial sputtering system with gas injection and substrate heater to implement in-situ cleaning and annealing of vias prior to barrier layer deposition and to combine the approach, along with Tsuchiya et al. and Hung et al. with Donnelly et al. to obtain an acceptable oxygen plasma sputter treatment and annealing process for via holes.

9. Claims 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Donnelly et al. in view of Tsuchiya et al., Hung et al. and Activac Technology Inc. Data Sheets, as applied to Claims 6 – 9 above, and further in view of Takagi et al. (US 6,174,796 B1).

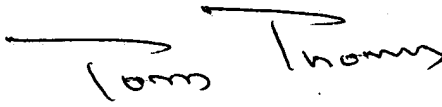
Donnelly et al. disclose (Col. 8, line 18) the use of a hydrogen plasma but do not disclose the use of hydrogen radicals. Further, there are no explicit disclosures concerning the process of deploying the hydrogen plasma. Takagi et al. disclose (Col.10, lines 4 – 13) a method of removing oxide (and other residuals) from surfaces by heating the surfaces in a hydrogen containing atmosphere or in a hydrogen plasma (containing radicals). It would, therefore, have been obvious to one of ordinary skill in the art at the time of the invention to combine Takagi et al., Hung et al., Tsuchiya et al., and Activac Technology Inc. Data Sheets with Donnelly et al. to obtain an "annealing" step in hydrogen to remove residuals and oxide remnants from the surface of vias, prior to deposition of the barrier metal lining the vias.

Art Unit: 2811

Conclusions

10. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to **Thomas Magee**, whose telephone number is **(703) 305 5396**. The Examiner can normally be reached on Monday through Friday from 8:30AM to 5:00PM (EST). If attempts to reach the Examiner by telephone are unsuccessful, the examiner's supervisor, **Tom Thomas**, can be reached on **(703) 308-2772**. The fax number for the organization where this application or proceeding is assigned is **(703) 308-7722**.

Thomas Magee
September 5, 2002


TOM THOMAS
SUPERVISORY PATENT EXAMINER
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